

**AMENDMENTS TO THE DRAWINGS:**

Figure 6 is amended to add Figure designations 54 and 56.

A sheet showing the Figure 6 amendments is attached at Appendix A.

A Figure 6 Replacement Sheet including the amendments is attached at Appendix B.

## REMARKS

Claims 2-9, 13-20, 24-31 and 35-43 are pending in the application.

Claims 10-12, 21-23 and 32-34 are cancelled from the application without prejudice and they are rewritten in independent form as new claims 38-43.

Claims 2-4, 6-9, 13-15, 17-20, 24, 26 and 28-31 are amended to more clearly set forth what the Applicant regards as the invention and/or to alter claim dependency and language to correspond to an amended independent claim.

New claims 35-43 are added to the application.

No new matter has been added to the application by way of these specification and claim amendments.

### I. THE ANTICIPATION REJECTION

Claims 6-9, 12, 17-20, 23, 28-31 and 34 are rejected for anticipation by Torkkola (USP 5,959,966). Independent claim 34 is cancelled from the application so the examiner's anticipation rejection will be discussed in the context of newly added independent claim 35.

#### A. All Rejected Claims Are Novel

Claim 35 is directed to using leading window results to initialise signal orthogonality for a following window, and then updating this using the following window. Orthogonality updated signals are then initialised using further leading window results and updated using the following window. Consequently Applicant's invention as now claimed in claim 35 relates to a method with two separate and sequential stages each of which comprises initialisation and update, but for different parameters, orthogonality and independence respectively. From claim 35 it is clear that independence is obtained only after orthogonality because the independence stage operates on results produced in the orthogonality stage. The use of two separate and sequential stages is explained in detail in the specification. (See e.g, page 13, lines 19-26; page 17 line 21 to page 18 line 21).

The examiner's novelty rejection relies upon Torkkola for teaching the use of a sliding window to process samples and using a separation matrix from a first window as an initial value in the second sample window. (col. 11, line 60 - col. 2 (*sic*), line 30). It appears that the examiner's reference to col. 2 of Torkkola is a typographical error and that the examiner intended

to refer to col. 12. The Examiner also explains that with regard to processing to achieve signal separation, Torkkola teaches a separation matrix (col. 11, line 60 - col. 12, line 30).

The Applicant does not take the position that initialising a current window with information obtained from an earlier window is novel. Indeed, such a procedure is not unusual in BSS techniques. However, the well known way to initialise a current window with information obtained from an earlier window does not work in the claimed invention: i.e. initialising a current or  $(k+1)$ th window  $X_{k+1}$  using the previous or  $k$ th window's inverse  $A_k^{-1}$  of the mixing matrix  $A_k$  does not work because it interferes with decorrelation as the Applicant has noted. (See specification Equation (1) page 12, page 13, lines 19 to 26 and page 17 line 21 to page 18 line 21). Applicant's invention as presently claimed in independent claim 35 is, therefore, novel over Torkkola.

One significant and patentable difference between Torkkola and the claim 35 invention is that Torkkola uses only a single update step while the claimed invention updates orthogonality and independence in separate steps. The single Torkkola update step is clear from, for example, Torkkola's Equations 5, 9, 12 15 and 20 - each of which is an expression consisting of a single step for calculating an update  $\Delta W$  for the unmixing or source separation matrix  $W$ . Column 10 lines 24-26 of Torkkola observes that it is better to accumulate  $\Delta W$  over a number of samples before updating  $W$ , but  $\Delta W$  remains a single update. Applicant's invention as claimed in claim 35 updates orthogonality and independence in separate steps to avoid interfering with decorrelation at step 23 in Applicant's Figure 3. Moreover, if Torkkola' approach of a single update matrix is used for fECG monitoring, the resulting separated signals would be susceptible to signal swapping as illustrated in Figure 4 of Applicant's specification. For at least this reason, independent claim 35 and corresponding dependent claims 6-9, 12, 17-20, 23, 28-31 are novel over Torkkola.

#### **B. Claims 6, 17 And 28 Are Independently Novel**

Claims 6, 17 and 28 are independently novel over Torkkola. Claims 6, 17 and 28 relate to an acquisition phase in which signals are separated and desired signals are identified and a subsequent phase in which only desired signals are processed to separation. The Examiner takes the position that column 4, lines 1-12 of Torkkola discloses removing the components of other mixed signals to recover a source signal. It is respectfully submitted that the Examiner is

confusing two entirely different things, i.e. separated signals and mixed signals. Claims 6, 17 and 28 are concerned with separating signals in an acquisition phase, then terminating the processing of some of the separated signals identified as unwanted and subsequently continuing to process the remaining separated signals identified as being desired signals. Torkkola column 4 lines 1-12 is concerned with the unmixing process itself, i.e. taking a multiplicity of source signals and separating out from it a single source signal. The difference between these two procedures can readily be appreciated from the fact that one can identify desired signals by inspection with a clinician's human eye or by pattern matching. (See Applicant's specification at page 29 line 26 to page 30 line 2). Neither approach is appropriate for removing components of mixed signals to recover a single source signal as per Torkkola - which requires a blind source (or signal) separation technique. For at least this reason, claims 6, 17 and 28 are independently novel

#### **C. Claims 7, 18 And 19 Are Independently Novel**

Claims 7, 18 and 19 are also independently novel over Torkkola. Claims 7, 18 and 29 relate to the signals associated with pairs of windows being statistical measures of data in the windows. (See specification at page 13 lines 7-10). It is the examiner's position that claims 7, 18 and 29 lack novelty at least because Torkkola teaches a separation matrix. Applicant does not understand the examiner's rejection because Torkkola's separation matrix  $W$  is completely different to data's statistical measures such as a covariance matrix. Torkkola's separation (or unmixing) matrix  $W$  is for operating on a vector  $x[n]$  of mixed (column 5 Equation (1) line 6) signals to produce separated signals (column 5 Equation (2) line 21). A covariance matrix does not separate signals; instead it provides information on the correlation between elements of a data matrix – a single matrix. If it is maintained that claims 7, 18 and 29 are novel because Torkkola does not disclose or suggest the claim features.

#### **D. Claims 9, 20 And 31 Are Independently Novel**

In relation to claims 9, 20 and 31, the Examiner observes that Torkkola teaches keeping up with fading corresponding to the speed of the transmitter and the receiver. (Col. 11, line 60 - col. 12, line 30). However, this is precisely the opposite of what is claimed in Applicant's claims 9, 20 and 31. Torkkola discloses the fading of data as received and before any processing, and more recent data fades more than older data. Applicant's claims 9, 20 and 31 relate to data which

is faded by processing it to fade progressively, and contrary to Torkkola, in the present invention, older data fades more than more recent data in order to bias processing in favor of more recent data. For at least this reason, claims 9, 20 and 31 are novel and patentable.

## **II. THE OBVIOUSNESS REJECTIONS**

### **A. Claims 2-3, 13-14 And 24-25 Are Non-Obvious And Patentable**

The Examiner rejected claims 2-3, 13-14, and 24-25 under 35 U.S.C. 103(a) as being unpatentable over Torkkola in view of "Characteristic-function-based independent component analysis" in Signal Processing, October 2003, Vol. 83, No. 10 by Eriksson et al. (Eriksson).

Claims 2 and 3 are non-obvious and patentable by virtue of their dependence upon independent claim 35 which is patentable as set forth in section I(A) above. Claims 13 and 14 are dependent upon new claim 36 and claims 24 and 25 are dependent upon new claim 37. Claims 13-14 and 24-25 are patentable at least by virtue of their dependency upon independent claims 36 or 37 which are patentable for at least the reasons discussed in section III below.

Regarding claims 2, 13 and 24, the Examiner acknowledges that Torkkola does not teach updating orthogonality using small updates to produce decorrelation in a second order statistics procedure. However, the Examiner states that Eriksson teaches a Jacobi type optimization to produce independent sources and optimizing orthogonality (p 2201, Section 4 and 4.1). The Examiner goes on to state that it would have been obvious to modify Torkkola's blind separation to include Eriksson's Jacobi-type orthogonal optimization to minimise the objective function using computationally convenient expressions (Eriksson, p 2210, Section 4).

It is respectfully submitted that Torkkola and Eriksson are not properly combined, because Eriksson relates to a procedure which Torkkola does not need and for which there is therefore no motivation for one of ordinary skill in the art at the time the invention was made to search for. In this regard Torkkola's invention is applicable only to radio signals: see column 3 lines 40-56, where it is stated that:

*“...the present invention uses a modified or less blind BSS process.....Knowing the modulation scheme by which the source signals are being transmitted in a digital system determines the symbol constellation ..... knowing the symbol constellation gives the PDF of the baseband source signals.....by making use of the known PDF, the present invention*

provides a BSS process and apparatus for recovering source signals transmitted from multiple mobile users”.

Torkkola is therefore not a true blind source separation process: instead it relies on knowing the modulation scheme, the symbol constellation and baseband source signals’ PDF (probability density function) – these are all unknown in a true blind source separation process. It makes Torkkola totally useless for the application described in Applicant’s specification to fetal ECG monitoring because the parameters which are known in Torkkola are not known in fetal ECG monitoring. Moreover, it means that Torkkola has no need for Jacobi. If for example Eriksson’s Jacobi were to be applied to Equation 1 of Torkkola, column 5 line 6, no useful result would be obtained because Jacobi is for use with unknown signals not Torkkola’s known signals. If the Examiner continues to combine Torkkola and Eriksson, Applicant respectfully requests the Examiner to specify clearly the Torkkola equation to which the Examiner envisages applying Eriksson’s Jacobi and why. Otherwise, the examiner should allow claims 2, 13 and 24.

Furthermore, even if Torkkola and Eriksson were to be combinable, Applicant’s invention as claimed in claims 2, 13 and 24 would not be rendered obvious because Eriksson uses Jacobi for the wrong process. Page 2201, section 4.1, line 1 of Eriksson refers to “finding statistically independent components” - this is a higher order statistics procedure (compare Applicant’s steps 25 and 27 in Figure 3): it is not a second order statistics procedure of updating orthogonality and producing decorrelation to which claims 2, 13 and 24 relate. Moreover, Eriksson does not mention small updates which appear in claims 2, 13 and 24. Here again the Examiner is respectfully requested to specify clearly the Torkkola equation to which Eriksson’s Jacobi is to be applied and why or to allow these rejected claims.

Similar arguments apply to claims 3, 14 and 25. Eriksson does not use Jacobi to update orthogonality, but instead to find statistically independent components. Eriksson page 2201, section 4.1, lines 2 and 3 envisages a different step – prewhitening – for orthogonalisation. Consequently the Torkkola/Eriksson combination also fails to render claims 2, 13 and 24 obvious.

The Examiner states that it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the blind separation, as taught by Torkkola, to include Jacobi-type orthogonal optimization, as taught by Eriksson, because then the objective function

would have been minimized using computationally convenient expressions (Eriksson, p 2210, Section 4). This is respectfully traversed, because:

- a) blind separation is not taught by Torkkola – see column 3 lines 40 to 56, where Torkkola makes it clear that his technique is less blind than conventional blind separation;
- b) Eriksson does not teach updating orthogonality using Jacobi, but instead finding statistically independent components; Eriksson uses separate prewhitening for orthogonalisation; and
- c) Torkkola does not mention either an objective function or its minimisation, so there appears to be nothing in Torkkola to which Eriksson can be applied: if the Examiner believes otherwise, here again Applicant respectfully requests the Examiner to specify clearly the Torkkola equation to which Eriksson's Jacobi is to be applied and why.

Claims 3, 14 and 25 are non-obvious and, therefore, patentable for this reason as well.

#### **B. Claims 5-6, 15-16 And 26-27 Are Non-Obvious And Patentable**

The Examiner next rejected claims 5, 6, 15, 16, 26 and 27 under 35 U.S.C. 103(a) as being unpatentable over Torkkola in view of Eriksson as applied to claims 3, 14 and 25, which Applicant respectfully traverses for reasons given above, and further in view of US Patent Application Publication 2001/0044719 to Casey (Casey).

Claims 5 and 6 are patentable at least by virtue of their dependence upon claim 35 which is patentable for the reasons recited in Section I above. Applicant has also demonstrated that Torkkola and Eriksson do not teach all the limitations of claim 3 upon which claims 4 and 5 depend, or those of claim 14 upon which claims 15 and 16 depend, or those of claim 25 upon which claims 26 and 27 depend.

Claims 4, 15 and 26 relate to using results obtained for each leading window to initialize independence of decorrelated signals associated with the respective following window in a second stage using independent component analysis to apply small rotation updates to initialise signals. As previously discussed, Eriksson does not teach using Jacobi to optimise orthogonality but instead to find statistically independent components.

The Examiner states that Torkkola and Eriksson do not teach higher than second order statistics: in fact as previously said Eriksson uses Jacobi to find statistically independent components, which is a higher order statistics procedure.

Casey mentions cumulative expansions up to a fourth order in paragraph 39, but this is to define a contrast function. Regarding claims 5, 16 and 27, the Examiner states that it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the blind separation combination, as taught by Torkkola and Eriksson, to include expansions up to a fourth order, as taught by Casey. If this objection is maintained, here again Applicant respectfully requests the Examiner to specify clearly the Torkkola equation to which Eriksson's Jacobi is to be applied, what resulting combination equation Casey is to be applied to, and what the justification is for doing so: in this regard:

- d) Torkkola does not require Casey to extract features from recorded signals, because Torkkola does this without expansions up to a fourth order which Torkkola cannot use. Instead Torkkola relies on knowing the modulation scheme, the symbol constellation and baseband source signals' probability density function;
- e) Eriksson describes a higher order statistics procedure making Casey redundant;
- f) Torkkola and Eriksson are not properly combined because there is no apparent equation in Torkkola to which Eriksson can be applied, and the Examiner has not indicated any such equation; and
- g) There is no Eriksson-modified equation in Torkkola to which Casey can be applied.

### **III. NEW CLAIMS 36-37 ARE PATENTABLE**

New independent claims 36-37 are added to the application in this Reply. New claims 36-37 are patentable at least because in each of the claims orthogonality and independence are updated in separate steps.

### **IV. NEW CLAIMS 38-43 ARE PATENTABLE**

Allowable claims 10-11, 21-22 and 32-33 have been cancelled from this application and rewritten in independent form as new claims 38-43. Claims, 38-43 are, therefore, believed to be

allowable.

## **CONCLUSION**

All pending application claims are believed to be patentable for the reasons recited above. Favorable reconsideration and allowance of all pending claims is, therefore, courteously solicited.

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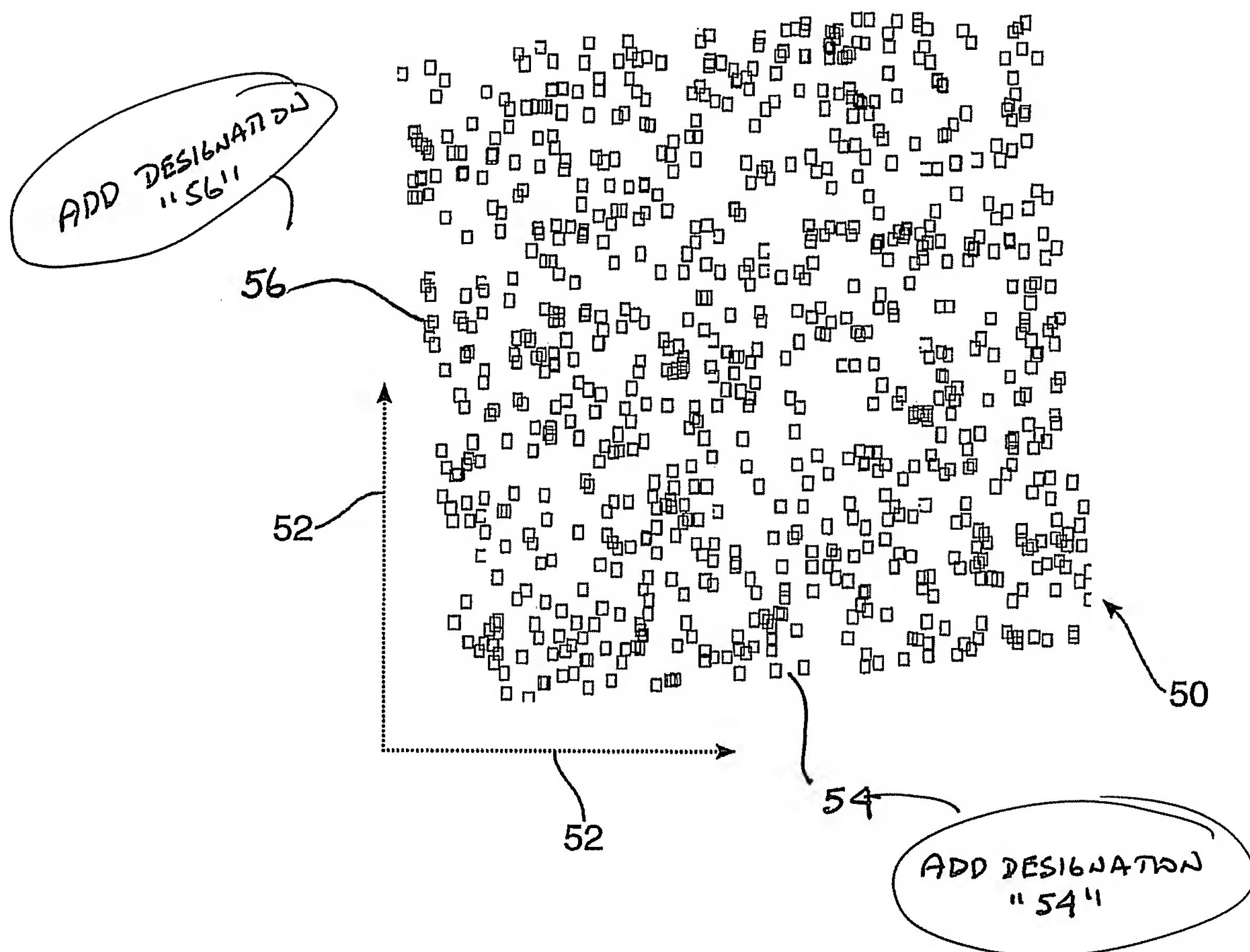
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## **Appendix A**

**(Figure 6 Marked Up to Show Changes)**

Fig.6.



## **Appendix B**

**(Figure 6 – Replacement Sheet)**